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BATHING WATER QUALITY AND HEALTH I-GREAT LAKES

Russell S. Smith, et al

Environmental Health Center
Cincinnati, Ohio

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Bathing Water Quality and Health

I - Great Lakes

A Study of Bathing Water Quality on the Chicago Lake Front and its Relation to Health of Bathers

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FOREWORD

This study of the possible relationship between illness occurring among bathers and natural bathing water quality was undertaken as one of the major objectives of the Tri-State Survey of Lake Michigan Waters conducted during the summer of 1948. The entire project was a cooperative one between federal, state, and local health agencies to determine the sanitary quality of shore water with particular reference to the bacterial quality of the water at public bathing beaches. The study was planned and coordinated by an Advisory Board. The representatives of the participating agencies serving on this Board were:

Chicago Board of Health	Dr. Samuel Hyman, Chief Medical Officer
Chicago Dept. of Public Works	Mr. J. R. Baylis, Engineer of Water Purification
Chicago Park District	Dr. L. B. Gordon, Medical Director
Cook County Dept.of Public Health	Dr. E. A. Piszczek, Director
Sanitary District of Chicago	Dr. F. W. Mohlman, Director of Laboratories and Mr. Langdon Pearse, Sanitary Engineer
Wisconsin Board of Health	Mr. L. F. Warrick, State Sanitary Engineer
Indiana Board of Health	Mr. B. A. Poole, Director, Bureau of Environmental Sanitation
Illinois Sanitary Water Board	Mr. C. W. Klassen, Technical Secretary, Chairman
U. S. Public Health Service	Mr. A. H. Stevenson, Sanitary Engineer, Technical Secretary

On this special phase of the project, Dr. John J. Phair, formerly Professor of Preventive Medicine at the University of Louisville, and now in a similar capacity at the University of Cincinnati, served as epidemiological consultant. His guidance and constructive criticism in reviewing initial drafts of this report were particularly helpful. Mr. Theodore D. Woolsey,

biostatistician of the Public Health Service Division of Public Health Methods, served as statistical consultant to the Board. Mr. Russell S. Smith served as field engineer in charge of the study for the Environmental Health Center. Bacteriologist Harold F. Clark of the Environmental Health Center was in charge of the bacteriological work performed at the Chicago South District Water Filtration Plant laboratory.

The epidemiological studies in two areas and determination of bathing water quality at adjacent beaches in this study were confined to the Cook County area. Particular acknowledgement is made of the valuable assistance given by the Chicago Park District through its Medical Director, Dr. L. B. Gordon, in furnishing a number of investigators, laboratory technicians, and other services to the study. The Cook County Department of Public Health, through its Director, Dr. E. A. Piszczek, and its Sanitary Engineer, Mr. Benn Leland, aided materially in furnishing a health education specialist and investigators for the epidemiological studies. It was originally planned to present the results of this epidemiological study as a supplement to the Preliminary Report, but the extent of the work and the fact that similar bathing water studies were planned for waters of different chemical composition and bacterial quality, located in other geographical locations, made it advisable to consider this as a separate project report.

1. INTRODUCTION

A. Bathing Water Quality Standards. For over a quarter of a century increasing concern has been manifested concerning the possibility of contracting illness by swimming in polluted natural waters. Concurrent with an increase in urban populations, there has been an extension of water carriage sewerage systems to the smaller communities, resulting in evident pollution of natural water over wider areas. In the same period, shorter working hours, improved transportation and changing attitudes of the public have increased the use of natural bathing places. These factors have led to the establishment of limiting factors for the quality of natural bathing waters. There are a number of such standards in existence in the United States. Many state health departments and the health departments of some large cities have adopted standards for outdoor bathing places. Standards, or limiting values, of water quality have been adopted, or recommended, by interstate groups for areas such as the Ohio River Basin, the Tennessee River Basin, the Great Lakes and Upper Mississippi Areas, and the Potomac River Basin.

All the standards have some items in common. All are based primarily on the bacteriological quality of the water using the density of organisms of the coliform group as an indicator of sewage pollution. Most of them are based upon the correlation of bacteriological and certain designated chemical and observational data, together with a sanitary survey to determine sources of potential pollution which may affect the body of water under consideration. The absence of toxic substances, free acids, floating solids, scum, oils, tars, and greases is often mentioned as a requirement.

The principal difference found in the standards is in the allowable coliform density. Primarily this is due to the fact that practically no accept-

able evidence relating coliform density of bathing water with the occurrence of human disease was available when these standards were adopted. Hence, the limiting coliform densities selected were frequently those generally attainable in the area involved. These allowable coliform densities vary from 50 per 100 ml. (expressed as a most probable number) in the Tennessee Valley ("Studies of the Pollution of the Tennessee River System, II," T.V.A., 1945, p 271) to 2,400 per 100 ml in New York City (Board of Health Declaration of Policy dated July 9, 1948), with most standards in the 500 to 1,000 per 100 ml. range.

The methods of expressing these permissible densities vary greatly and tend to make the divergence between bacterial requirements even wider. In some standards, the value given is the maximum permitted, presumably on the basis of the determination for any one sample. In others, it is the average of a series of samples, but the type of average, whether arithmetic or logarithmic, is not stated. In some standards, an occasional overrun of the limiting concentration is permitted and under one standard, 20 per cent of the samples may exceed 1,000 per 100 ml.

B. Objectives of Epidemiological Studies. The wide variations in the bacterial quality for natural bathing waters permitted by several existing regulations and the lack of evidence concerning the amount of bacterial pollution detrimental to health of bathers clearly indicated the need for studies correlating the general health level of bathers with the bacterial quality of the bathing waters. A survey of this type was included as one of the major purposes of the Tri-State Survey of Lake Michigan Waters in 1948 and represented the major portion of the work conducted in Cook County.

The epidemiological studies had two principal objectives. One was to obtain dependable data on the relationship between bathing quality and illness among bathers, which eventually might lead to the possibility of delineating

acceptable limits of quality for natural bathing waters. It was realized that before a final goal could be reached, a series of similar studies would be required in other areas where waters of different quality and type could be found. It was anticipated that this survey would provide the initial increment of information needed. The second objective was to develop and test methods for gathering reliable data concerning minor illness and activities from a large population at minimum cost.

C. Definition of Problem. Consideration of the possibility of acquiring disease from bathing in natural waters that might be subject to pollution immediately suggested the possibility of increased incidence of typhoid, dysentery, and similar enteric diseases. Epidemics of typhoid have been traced to bathing in polluted waters. Scott (1) cites a study by Ciampoli and Hitchcock of 61 cases of typhoid in 1923 which concluded that most of the cases were due to swimming in polluted waters of New Haven Harbor. The Committee on Bathing Places of the American Public Health Association and the Conference of State Sanitary Engineers in their report for 1922 (2) note a report by health officials in Florida of an epidemic of typhoid at a school camp that was definitely traced to bathing in a polluted stream.

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(1) Survey of Connecticut's Shore Bathing Waters. Warren J. Scott. Connecticut Health Bulletin, December, 1931.

(2) Transactions of the Third Annual Conference of State Sanitary Engineers. Public Health Bulletin 133.

The morbidity rates for such diseases, however, are normally very low in urban populations, and it was quite possible that no cases would have been found during the survey period. Therefore, it was decided that reliance must be placed on occurrence of minor skin, eye, ear, respiratory and gastro-intestinal illnesses that might be expected to follow contact with, or ingestion of, polluted water. Various references to such outbreaks from bathing in natural waters are found in the literature. The previously mentioned report of the Committee on Bathing Places notes an outbreak of ear infections attributed to bathing in natural lake waters at Waterville, Maine, and an intestinal epidemic traced to bathing in a polluted stream in Santa Fe, N. M. An outbreak of diarrhea involving 75 cases among children was traced to wading in polluted beach waters in Santa Cruz, Calif. (3) Such illnesses, however, are fairly common among the general population and are frequently of such nature that most of the cases would not receive medical attention.

These factors made it necessary that reliance be placed on gathering information from sufficiently large population groups that sub-groups would provide samples of sufficient size for the derived conclusions to be statistically significant. The method adopted for collecting, recording and tabulating the desired information had to minimize the possible under-reporting of minor illnesses. Furthermore, it was desired that these objectives be obtained with a minimum of field workers in order to keep the cost of the survey as low as possible.

To fulfill these conditions it was determined that the study should be based on total illness incidence of certain types, that comparisons would be made between measures of illness for bathers in each of two areas with dif-

(3) Outbreak of Diarrhea Traced to Beach Pollution. California's Health, September 1946.

fering quality of shore waters and that approximately 1,000 families would be required in each area to provide a sufficient number of illnesses for the analysis. It was concluded also that the only practical method of obtaining the desired information within the available budget would be by means of familial diagnosis of illness and family recording of data.

II. SURVEY METHODS

A. Selection of Areas. In the selection of areas for this study, certain factors were considered of paramount importance. These factors were:

1. Two frequently used beaches with a marked difference in bacterial water quality;
2. A large stable population immediately adjacent to each beach;
3. Similar socio-economic levels in the population to be studied.

It was realized that bathers in water of good quality would have a higher incidence of illness than those that did no swimming. This is demonstrated in a study made at Phillips Academy, Andover, Mass., of hospital admissions of non-swimmers and regular swimmers over a period of seven years (4). In this study, it was found that hospital admissions on account of respiratory illness averaged 7.5 per cent higher in the swimming group. Therefore, the non-swimmers would not serve as a satisfactory control group to determine the effect of water quality on the bathers' health and it was necessary to select two areas with different water qualities.

(4) Swimming Pools. J. Roswell Gallegher. New England Journal of Medicine, 238, 899 (1948).

It was considered necessary to have a large population immediately adjacent to the beach. It was anticipated that, in such an area, a sufficient number of residents to provide a satisfactory sample would go bathing at the beach selected for study. It was also believed that people living near the beach would be more frequent bathers than those who had to travel a considerable distance. Furthermore, in order that contact might be maintained with the family groups under observation, it was essential that they be permanent residents living within a relatively limited area rather than being scattered over much of the city.

Two areas were selected which met essentially these criteria. One was near the north limits of Chicago, and the other was on the far South Side. The bacteriological results of bathing water samples from Morse Avenue in the north area and 75th Street in the south area that were examined by the Health Department of the Chicago Park District during the summer of 1947 indicated average coliform densities of 697 and 3560 respectively. Thus it was estimated that the waters of the south area had a coliform density five fold those of the north area.

The northern area was near the north limits of Chicago and was bounded by Greenleaf Avenue on the north, Loyola Avenue on the south, Lake Michigan on the east and the tracks of the Evanston branch of the elevated railway on the west. This area was designated as "North Beach" and is shown as an aerophotograph on a 1:12,000 scale in Figure 1. The area had been developed principally with large apartment buildings and there were but few individual homes. Most of the bathing was done at Loyola Park on the wide beach between Greenleaf Avenue and Pratt Boulevard. The street end beach at Albion Avenue was also well patronized, but the small beach at the end of Pratt Boulevard was used by very few people.

The other area selected was near the south limits of Chicago and extended from 71st Street on the north to Cheltenham Place on the south and from Lake Michigan west to approximately one block west of Exchange Avenue. This area was designated as "South Beach" and is shown on a 1:12,000 scale in Figure 2. This area was not as completely developed with large apartment houses as was the North Beach area. There are many two and three family apartments, quite a number of individual homes and many single houses altered to shelter two families. Most of the swimming in this South Beach area was on the wide municipal beach from 75th to 78th Streets. The small beaches north of 73rd Street and south of 74th Street were private beaches. The small beach just north of 75th Street was quite popular, but was never as crowded as the beach south of 75th Street.

The relative location of the two areas is shown in Figure 3. In general, the people of the two areas were quite similar. A rather high proportion of the families in each area live in apartments, rentals were about the same, and the socio-economic patterns appeared to be similar in all obvious details.

B. Field Survey Methods. The customary method of conducting an epidemiological survey of illness incidence is for a staff worker to visit each household at intervals of a week or 10 days, and by personal interview, obtain the necessary information and enter it on a data sheet. It was realized during the planning stage that it would be impossible, with the field force available, to conduct the present survey in this manner and that it was imperative that a substitute method for gathering the data be devised.

The method selected was to contact as many households in the study area as possible, obtain the agreement of the housewife to cooperate in the study and rely on her to enter the necessary data on a calendar form which would be collected at the end of the survey. To maintain the interest of the coop-

erating families in the survey and to aid in obtaining properly completed schedules, each household was to be contacted at intervals during the summer by personal visit, telephone and mail.

A family record form was prepared for the housewife to use to record daily, by means of an indicated code, the swimming and illness experience of each member of the household. This form also contained space to record the householder's name, address and telephone number, as well as the name, age, sex, familial relationship and any chronic illness for each individual in the household group. A mimeographed letter of instructions giving the necessary details regarding the use of the family record forms was left with the family. Each cooperating household was assigned a file number which was inserted on the family record forms and corresponding office record card. The office record card form was prepared on 5" by 8" file cards to record the name, address, telephone number and number of individuals in the household group for each cooperating family. This office record card also provided for recording the date and method of all staff contacts with the family. All basic data on these forms and cards were completed by the field worker at the time of the initial visit. Reproductions of these forms are shown in Appendix A.

In order to publicize the project and to acquaint people with its purpose before the field worker rang the doorbell, news stories describing the study appeared in the Chicago metropolitan newspapers and community newspapers in the two areas selected for study. Spot announcements were made on radio programs of the various broadcasting stations serving the areas. The medical profession was notified of the study and its purpose through the Cook County Medical Association. As a further means of bringing the project to the attention of the public, mimeographed flyers showing the

FIG. 1
NORTH BEACH
STUDY AREA

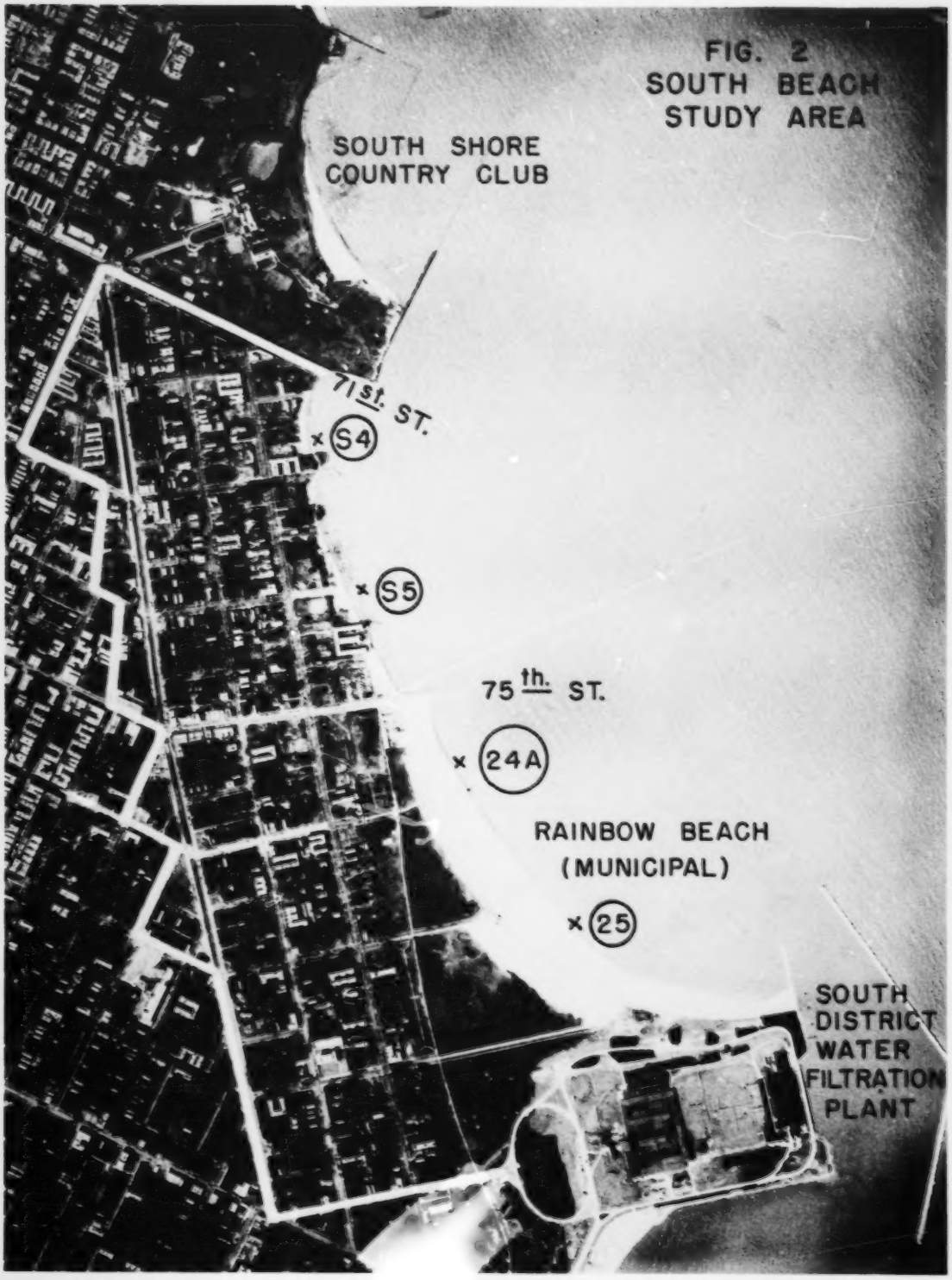


FIG. 2
SOUTH BEACH
STUDY AREA
SOUTH SHORE
COUNTRY CLUB
71st. ST.
S4
S5
75th. ST.
24A
RAINBOW BEACH
(MUNICIPAL)
25
SOUTH
DISTRICT
WATER
FILTRATION
PLANT

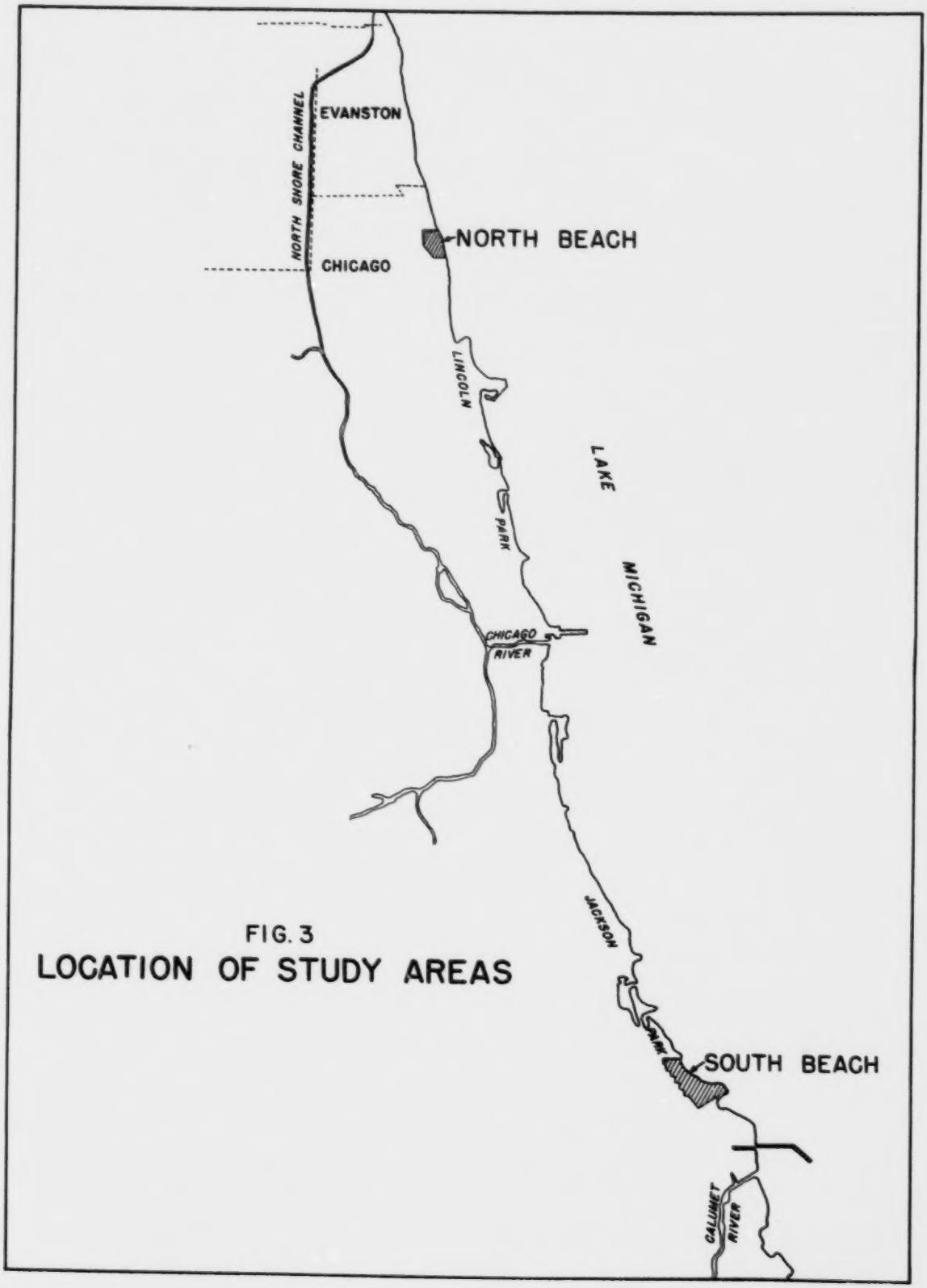


FIG. 3
LOCATION OF STUDY AREAS

purpose of the study were prepared and delivered to each dwelling unit in the selected areas. A copy of this flyer is included in Appendix A.

Eleven medical students were employed by the Chicago Park District and assigned to the project as laboratory technicians, sample collectors and field investigators. These employees, together with two student employees of the Cook County Board of Health and a sanitary engineer loaned by the District Office of the Public Health Service were assigned to the task of obtaining in each study area 1,000 families that would agree to cooperate in the survey.

Before starting the field work, the nature and purpose of the project was explained to these workers. Instructions on the method of filling out the family record form and office record card were furnished each worker (See Appendix A). A particular section of one of the areas was assigned to each individual, who was instructed to attempt to contact each family residing in his section to explain the purpose and intent of the survey and to endeavor to obtain the cooperation of the family. In a period of two weeks, commencing June 28, the field workers had secured the promised cooperation of 1,023 families in the North Beach area and 1,038 families in the South Beach area. Approximately 50% of the families in the two areas could be reached for an interview. Of the families interviewed about 67% agreed to cooperate in the survey. Thus better than one in every three families in the two areas participated in the study. It is of interest that a family unit in the North Beach area averaged 3.1 individuals, while in the South Beach area it averaged 3.4.

After the distribution of the family forms had been completed, most of the personnel were assigned to other duties. Five were retained on the epidemiological work to maintain contact with the cooperating families. Repeat

visits and telephone calls were made to encourage housewives to keep the record current and to answer any questions that arose concerning the method of making entries.

Collection of the family forms by the field workers was started on August 26 and completed by September 7. About 50 per cent of the cooperating families were found at home when the field worker called. When no response could be obtained, a letter was left, together with an addressed and stamped envelope, explaining again the importance of the survey and requesting that the record form be completed and mailed to the survey office. This "Non-contact pick-up letter" is shown in Appendix A. By these means, 814 (79.6 per cent) of the North Beach area forms and 813 (78.3 per cent) of the South Beach forms were recovered, an overall recovery of 78.9 per cent.

On the basis of the results obtained by the methods employed in this survey, it may be estimated that 1,000 completed family record forms representing approximately 3,000 individuals will require the agreed participation of about 1,300 families. This will mean interviewing 2,000 families in an area containing 4,000 family dwelling units or a population of approximately 12,000.

C. Shore Water Examinations. As a part of the Cook County section of the Tri-State Survey of Lake Michigan Waters, bacteriological samples were taken of the shore waters of the North Beach and South Beach areas throughout the period of this investigation. Three sample points were located on the North Beach and four on the South Beach. The location of these sample points (9, S2, and S3 on the North Beach; and S4, S5, 24A and 25 on the South Beach) are shown in Figures 1 and 2. As the bacteriological work was a part of the Tri-State Survey, the sample point designations from that survey were used for this special study to avoid confusing the field personnel.

The sample points were selected in relation to the expected maximum

bathing concentration. They were located and described with reference to fixed marks in order that samples would always be taken at the same place. A combination "Sample-Laboratory Card" was devised on which all field data were to be recorded. This card accompanied the sample through the laboratory and was used to record all laboratory data. After completion of the laboratory work, all data from the cards were transcribed to special "Master Sheets" for permanent record. All data from an individual sample point was shown chronologically on a series of "Master Sheets." The "Sample-Laboratory Card," the "Master Sheet," the "Instructions for Sample Collectors" and the description of the sample points on the North and South Beaches are shown in Appendix B.

All samples were collected by wading out from shore to a little beyond knee depth (about two foot water depth) and scooping the sample from about six inches below the surface. As life guards at the beaches would not permit bathing beyond chest depth (about 4-1/2 feet), the samples were taken in water representative of that encountered by the majority of the bathers.

As soon as the sample was collected, it was placed in an iced container and kept refrigerated until it reached the laboratory. Coliform determinations were made on all samples in accordance with "Standard Methods for the Examination of Water and Sewage (Ninth Edition) 1946." All lactose broth tubes showing gas in any amount within 48 hours were confirmed, using brilliant-green bile lactose broth. Three tubes in each of three or more decimal dilutions were planted. Results were reported as "Coliform most probable number per 100 ml." (Coliform MPN per 100 ml.).

The laboratory work was done in the bacteriological laboratory of the South District Filtration Plant of the City of Chicago by medical students, employed by the Chicago Park District, working under the direct supervision of Bacteriologist Harold F. Clark of the Environmental Health Center.

During the 63-day study period from June 28 to August 28, thirty one sets of water samples were taken on the North Beach and 36 sets were taken on the South Beach. The coliform densities as determined from these samples are given in Table 1.

TABLE 1 - COLIFORM DENSITIES (M.P.N. PER 100 ML.)

Date	North Beach				South Beach				
	9	S2	S3	Geom. Mean	S4	S5	24A	25	Geom. mean
July 8	93	240	43	99	33	23	23	39	26
9					43	23	240	23	48
10	23	460	93	99	93	150	230	43	108
11									
12	240	240	93	175	93	240	150	240	168
13	2400#	3500#	930#	1980	24000	2400	7500	+1100	5680*
14									
15	430	430	430	430	930	2400	750	390	900
16					93		2400	240	377
17	43	43	23	35	23	230	91	230	103
18									
19	43	230	230	131	43	230	2400	930	386
20	43	240	150	116					
21									
22	43	43	460	95	93	2400	930	930	663
23	460	930	230	460	1500	4300	2400	2400	2470
24	43	460	150	144					
25									
26					93	460	930	460	368
27	9.1	93	23	27	240	750	150	240	284
28									
29	23	460	23	62	430	430	430		430
30	23	23	43	28	43	93	93	93	76
31	23	23	23	23	43	93	23	4600	143
Aug. 1					93	2400	43	240	219
2	23	43	43	35	240	430	150	75	185
3	1100	460	460	615	460	430	240	93	258
4									
5					1100	460	930	930	813
6	460	93	240	218					
7	43	43		43	93	240	2400	460	396
8					+1100	150	240	4600	795*
9	240	240	240	240	93	240	460	460	262
10	210	1100	150	326					
11							240	93	149
12	23	36	36	31	23	23	36	36	29
13	91	36	430	112					
14	230	230	150	200	230	230	91	430	213
15									
16	23	36	23	27	23	36	91	430	75
17					23	36	36	91	41
18									
19	73	91	36	62	230	430	23	91	120
20	23	230	36	58					
21	36	2400	36	146	23	36	91	23	36
22					91	23	36	73	49

TABLE 1 - COLIFORM DENSITIES (M. P. N. PER 100 Ml.) Cont'd

Date	North Beach				South Beach				
	9	S2	S3	Geom. Mean.	S4	S5	24A	25	Geom. Mean.
Aug. 23	23	230	91	79	73	91	930	36	122
24	23	91	23	36	36	23	91	23	36
25									
26	23	23	23	23	91	150	230	91	130
27							230	36	91
28							930	230	463
Minimum	9.1	23	23	23	23	23	23	23	26
Lower Quartile	23	43	30	35	43	36	91	73	76
Median	43	230	92	99	93	230	230	230	176
Upper Quartile	210	430	230	175	240	430	930	460	386
Maximum	2400	3500	930	1980	24000	4300	7500	4600	5680 *

Median for All Beach Samples

North Beach	91
South Beach	180

* Equal to or greater than figure shown.

\+ Indeterminate, but greater than figure shown. (+1100 has been assumed as 2400 in computing geometric means because if another decimal dilution had been planted and all 3 tubes had been negative, the M.P.N. would have been 2400).

\- Indeterminate, but less than figure shown.

\# Median of 7 samples at Points 9 and S3. Average of 2 samples at Point S2.

In general, the water on the South Beach had higher coliform densities than that on the North Beach, but the difference was not as great as had been anticipated. The general quality of the water in both areas was very good for shore waters of a natural fresh water lake, particularly adjacent to a large center of population. There were no periods of more than one day when the coliform densities reached levels that would indicate more than slightly polluted natural water. On only two days was a mean coliform density in excess of 500 per 100 ml. found on the North Beach and on only five occasions did the mean density exceed 300. On July 13 the mean coliform MPN was 1,980. High coliform densities were general along the entire lake front on that particular day. Only on two occasions did the mean coliform density on the South Beach exceed 1,000 per 100 ml. On July 13 the mean was 5,680 and on July 23 it was 2,470.

During the entire summer a total of 363 individual samples were taken at the seven sample points on the two beaches. These included 99 samples at times of special sampling at two-hour intervals at some of the points. In general, the results of these special samples and of the samples taken prior to July 8, are not shown in Table 1. Only two samples or (0.55 per cent) had a coliform MPN in excess of 10,000 per 100 ml. These were the sample at Point S4 on the South Beach on July 13 and one of seven samples taken at Point 9 on the North Beach on the same date.

By arranging all the results of the routine samples, including those collected prior to July 8, from the three sample points on the North Beach and from the four sample points on the South Beach in percentage frequency tables, the relative bacterial quality of the waters in the two areas is more readily apparent. Such percentage frequency distribution are shown in Table 2.

TABLE 2. COLIFORM DENSITY DISTRIBUTION
M.P.N. PER 100 Ml.

	North Beach	South Beach
Number of Samples	104	160
Median	43	150
Density Range	**Per Cent of Samples**	
240 or less	84.62	68.75
Over 240	15.38	31.25
Over 460	3.85	18.75
Over 1,100	0.96	9.38
Over 10,000	0.00	1.25

An attempt was made to determine whether the coliform content of the beach waters could be correlated with the number of bathers. On five occasions water samples were taken at two-hour intervals from 9 A.M. to 9 P.M. at two sample points on the North or South Beach and the bathing load determined at the time of sampling. No correlation could be established between the bathing load and the coliform MPN, but the bacteriological data are of interest in showing the variation in coliform densities over a twelve-hour period at a single sample point and the difference in apparent bacterial quality of the water at a given time at two adjacent sample points under apparently similar conditions on a single beach. These data are presented in Table 3.

TABLE 3 - COLIFORM VARIATIONS OVER 12-HOUR PERIODS

Date	Sample Point	Coliform MPN per 100 ml						
		9 AM	11 AM	1 PM	3 PM	5 PM	7 PM	9 PM
		North Beach						
7/13	9	930	1,500	2,400	2,400	4,600	11,000	1,500
	S3	930	2,400	930	910	2,400	230	930
7/18	9	230	4,300	4,300	750	2,400	930	930
	S3	230	2,400	230	91	93	460	460
		Distance between sample points - 2,000 feet						
		South Beach						
7/25	24A	230	230	150	760	2,400	230	—
	25	430	36	91	130	36	230	—
8/10	24A	240	93	23	93	240	43	23
	25	460	93	43	240	150	93	93
8/18	24A	150	430	2,400	930	430	2,400	4,600
	25	36	150	73	430	930	430	430
		Distance between sample points - 1,300 feet						

D. Sanitary Surveys. Sanitary surveys indicated that there was very slight probability of sanitary sewage entering Lake Michigan along the Chicago lake front. Normal sewage flows are diverted to the intercepting sewers and sewage treatment plants of The Sanitary District of Chicago and the effluents discharged to the various Sanitary District channels, which in turn discharge into the Desplaines

River at Lockport. The Desplaines River joins the Kankakee to form the Illinois River, a tributary to the Mississippi River. All storm water overflows from combined sewers in the City of Chicago discharge to the channel system and hence are normally prevented from reaching the lake.

In the village of Evanston, north of the city limits of Chicago, there are five storm water relief overflows from the combined storm and sanitary sewers. According to information furnished by The Sanitary District of Chicago, only one of these overflows (that at Davis Street, two and one-half miles north of the North Beach area) was in operable condition during the period of this study, the others being temporarily blocked by sand.

There are 112 storm water drains in the various parks along the Chicago lake front. Most of these discharge into the various small boat harbors. The results of bacterial examination of samples taken at frequent intervals from the outlets of these harbors indicated that these drains had no significant effect on the sanitary quality of the shore waters. In addition to these storm drains in the parks, there are many surface or gutter drains serving short street ends abutting on the lake shore and several storm water outlets in small areas not included in the park system.

The mouth of the Calumet River is approximately two miles southeast of the South Beach area with a long breakwater forming the north boundary of Calumet Harbor between the river and the beach. The shortest water distance from the beach to the river is approximately four miles. The flow in the Calumet River is normally away from the lake into the Sanitary District channel system, although there is only a small current. The amount of lake diversion is controlled by operation of the locks at Blue Island, fourteen miles inland from the mouth, and is ordinarily sufficient to prevent reversals. According to records of the Sanitary District of Chicago, there were only two reversals in

1948, totalling 117 hours, but neither of these occurred during the period of this study. Observations of apparent direction of flow at time of collection of water samples indicated that on July 19 and 30 and on August 26 there was a slight movement of surface water toward the lake. On two of these occasions the prevailing wind was such that these water movements might have been due to wind effects on the water surface, but in the third instance the prevailing wind was from the lake.

Between 79th Street and the Indiana state line, there are two large mills producing pig iron and two malting companies on or near the lake front. Sanitary surveys of these plants showed that the industrial wastes from the malting plants and all sanitary wastes are discharged to the Chicago sewers. Cooling water, quenching water and gas washer wastes from the steel mills discharge in part to the lake. The gas washer wastes contain considerable iron ore dust, a portion of which reaches the lake in Calumet Harbor and gives a distinct reddish tinge to the water. This was not considered to have been of sanitary significance. Only one of the steel companies operates a coke plant at this location and the phenolic waste is discharged to the Chicago sewers.

Just across the state line in Indiana is a plant of a corn products company. Sanitary sewage from this plant is diverted to the Hammond, Indiana, city sewers and sewage treatment plant. Under a stipulation of the Supreme Court of the United States, however, the company is permitted to discharge to the lake approximately 300 pounds of corn sugar per day along with several million gallons of indirect process water which has been used in part for cooling purposes. The discharge, which enters the lake in shallow water approximately five feet deep and 400 feet off shore, has a milky turbidity and two samples taken over the outfall in the lake on August 20 and 27 had coliform

most probable numbers of 9,300,000 and 4,600,000 per 100 ml. The point of discharge is 5.5 miles from the South Beach. This waste may have had an effect on the coliform density in the lake waters out of proportion to its sanitary significance. Since the field work on this study was completed, the plant has installed chlorinators and is now chlorinating the raw water to the plant and the waste discharged to the lake.

To summarize, there was no detected point of discharge of sanitary sewage, either raw or treated, within 2-1/2 water miles of the North Beach (and this only during times of heavy rain) or within 4 water miles of the South Beach.

E. Methods of Analysis. The study was planned to compare illness rates among swimmers at the two selected beaches. It was evident that the illness rates between the two population groups must be adjusted for comparable subgroups in the two areas doing equivalent amounts of swimming. In consideration of the possibility that this approach might not yield the desired information, it was decided that the method of recording data should also make possible relating illness with swimming on any particular days when the bacterial density was unusually high in the shore waters at either of the two beaches.

To obtain the desired information without undue reliance upon the memory of numerous individuals and because the employment of field investigators was limited, the family record form previously described was made up as a calendar sheet. On this sheet could be entered, by use of appropriate symbols, a daily record showing whether or not each individual was in the water at the local beach and the approximate duration of exposure, as well as the type and days of occurrence of any of various illnesses. This form allowed the expression of amount of illness either in terms of the total number of days of illness, or in terms of number and duration of separate illnesses experienced. The calendar schedule, although yielding data that were probably less accurate than could have been obtained by repeated interviews at short intervals, was satisfactory in all except minor respects.

In preparation for transferring the data to standard 80-column punch cards for machine tabulation, an office code sheet was devised to allow the entry of all desired information. The "Code Sheet" and the accompanying list of codes and special instructions are shown in Appendix C.

This "Code Sheet" provides for coding under a file number for each individual the particulars as to age, sex, chronic illness, number of days of record for the individual and details of his swimming and illness experience. It will be noted that under "swimming experience" provision is made for coding for certain days if the individual went swimming at the local beach (and whether he was in the water for less than half an hour). These days were selected to obtain three days (July 13, 15 and 23) when the general level of coliform densities was highest on both of the beaches. Similarly, three days (July 30, August 12, August 24) were selected as days when the level of coliform densities was low on the two beaches. Under illness experience, provision was made for coding the total days ill and also details concerning the first five illnesses suffered by the individual. An "illness" was defined as a continuous period of one or more days for which an illness symbol or combination of symbols was recorded. The details coded for each illness covered type of illness, date of onset and swimming experience during the week prior to date of onset. After coding was completed, the information was transferred to punch cards for the customary machine tabulation.

III. OCCURRENCE OF ILLNESS

Three primary methods of analysis were used: (1) a comparison of illness rates between groups of swimmers doing equivalent amounts of swimming at the two beaches with illness expressed both as total days of illness and the number of separate illnesses experienced; (2) a comparison of illness experienced in

the week following swimming on three days of high coliform densities with corresponding data following swimming on three days of low coliform densities; and (3) for people taken ill a few days after swimming, a comparison of the number of illness cases for waters with different levels of coliform density. The last method made use of more of the available data than the method based on the six specified days, but it was subject to more difficulties in coding and tabulating.

A. Method 1 (Prevalence)

As mentioned previously, 78.9 per cent of the family record forms originally distributed were returned. These covered the swimming and illness experience of 5,124 persons from approximately 1,600 households. The number of days of record averaged 57.1 per person. Thus, there was a total of 292,611 person-days of record, divided into 154,453 person-days for the North Beach area, and 138,158 for the South Beach area.

A summary of the percentage of person-days on which there was swimming at the neighborhood beach and the percentage of days on which illness was reported is given in Table 4 for all ages. A detailed breakdown of these percentages by age groups is given in Appendix D, Table 1.

TABLE 4 - PERCENTAGE OF TOTAL PERSON-DAYS WITH REPORTED NEIGHBORHOOD BEACH SWIMMING AND REPORTED ILLNESS

Area	Without Chronic Illness		With Chronic Illness	
	Males	Females	Males	Females
	Reported Swimming			
North Beach	10.5	10.9	8.7	8.0
South Beach	11.1	10.5	9.9	9.7
	Reported Illness			
North Beach	2.4	3.0	4.8	4.7
South Beach	3.2	3.8	7.5	9.1

There was no great difference in the amount of swimming at the neighborhood beach by the persons living in the North and South Beach areas. There appears to have been more illness among both males and females in the South area, but these data do not indicate whether this is a function of water pollution or was caused by some other factor, such as a difference in age compositions of the two populations or a difference in severity of illness to be considered reportable. Likewise it is evident that many of the chronic illnesses reported were not of sufficient importance to prevent swimming, for the people in the

North Beach area reporting chronic illness did 78 per cent as much swimming as those not reporting chronic illness. In the South Beach area this figure was 91 per cent.

The ratio of South to North for percentage of person-days of illness for people with chronic ailments was 1.75 and for people without chronic illness was 1.30. These ratios, together with the greater amount of swimming by chronic ailment individuals in the South area might indicate more liberal reporting of illness in the South Beach area. However, because of the evident differences in the swimming and illness experience in the groups with and without chronic ailments, the persons with chronic conditions have been omitted from some of the following analyses.

In Table 5 the persons without any chronic illness condition have been divided into four groups according to number of swimming-days. Within each of these groups, the people are approximately comparable in respect to amount of exposure to bathing water in the two areas. Illness rates, expressed as percentage of person-days on which illness was reported, have been computed for swimming-frequency groups by sex for each area. The breakdown of these data for age groups is shown in Appendix D, Table 2.

TABLE 5 - PERCENTAGE OF PERSON-DAYS WITH REPORTED ILLNESS BY AREA, SEX AND SWIMMING FREQUENCY (NON-CHRONIC AILMENT PERSONS ONLY)

Group	Swimming Frequency - Days				Number of Persons in Group
	0	1-9	10-24	Over 24	
North Beach - Males	1.2	2.7	4.3	5.0	1,033
South Beach - Males	2.4	3.5	3.9	6.4	1,048
North Beach-Females	1.9	4.1	4.2	3.5	1,132
South Beach-Females	3.3	3.9	5.1	3.6	1,126

On the basis of the percentages for all ages combined, it is evident that for the "no swimming" groups, both male and female, there was more illness reported in the South area than in the North area. In the swimming groups, however, the differences do not follow the same pattern, nor are they consistent among themselves. In the groups that did little swimming, (1-9 days), North Beach males reported a lower percentage of illness days than South Beach males and the ratio was reversed for females. In the groups that did a moderate amount of swimming (10-24 days), North Beach males reported a higher percentage of illness days and North Beach females a lower percentage than the corresponding groups in the South area.

These apparent inconsistencies might be due to differences in the age composition of the populations of the two areas. Figure 4 was prepared from the data in the last column of Table 2, Appendix D, to illustrate the percentage age distribution of the two survey populations. This figure shows that the age distribution of the two populations are remarkably similar. A corresponding similarity can be shown for the age distribution of the male and female survey populations in the two areas.

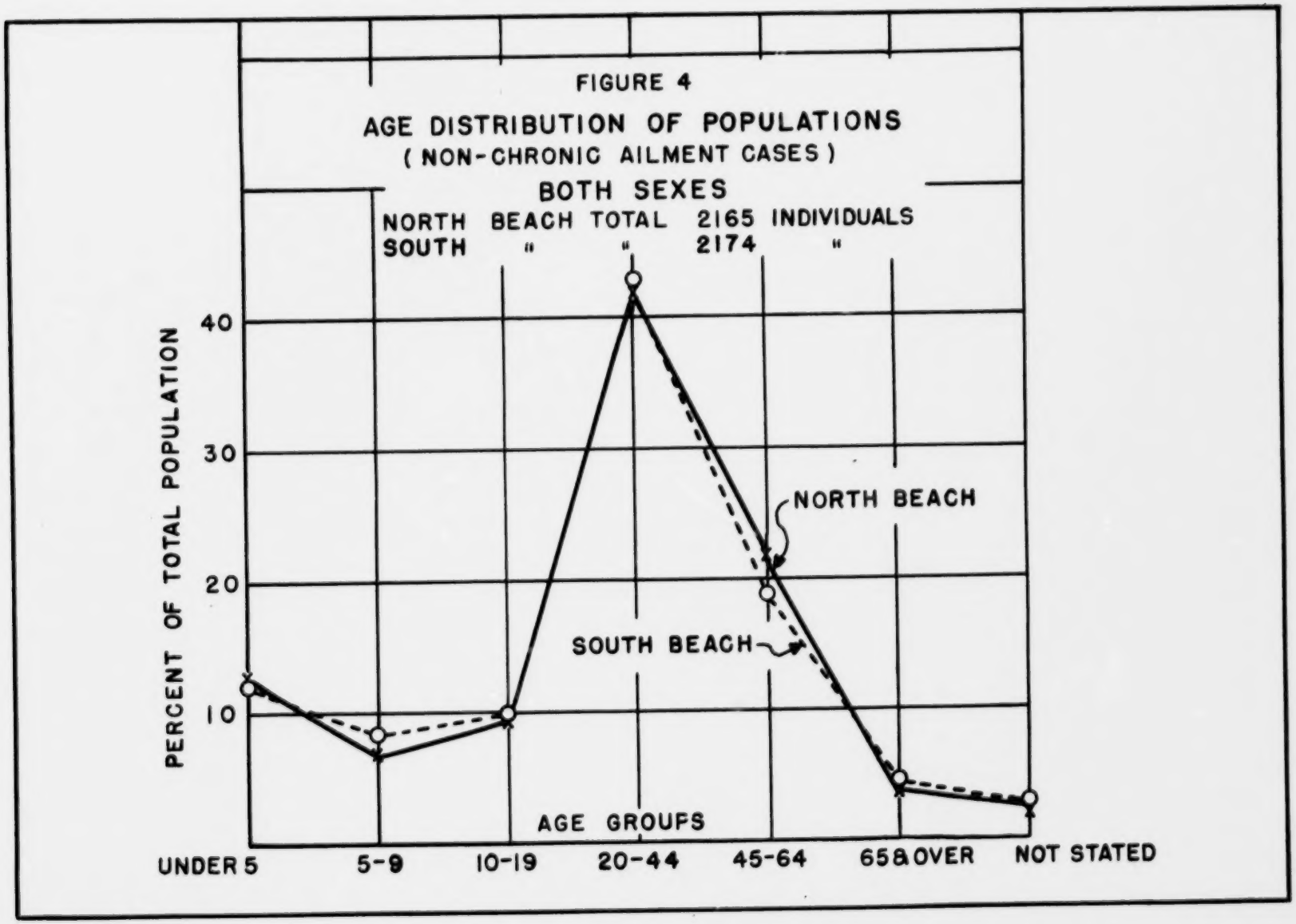


FIGURE 4
AGE DISTRIBUTION OF POPULATIONS
(NON-CHRONIC AILMENT CASES)
BOTH SEXES
NORTH BEACH TOTAL 2165 INDIVIDUALS
SOUTH " " 2174 "
PERCENT OF TOTAL POPULATION
40
30
20
10
NORTH BEACH
SOUTH BEACH
AGE GROUPS
UNDER 5
5-9
10-19
20-44
45-64
65& OVER
NOT STATED

In Table 6, the percentages of person-days of illness for all ages have been adjusted to equalize for all groups the variation due to association of amount of illness with age[1]. In this adjustment, the experience of persons over 64 years of age and those with age not stated has been omitted, as Table 2, Appendix D, shows that the number of person-days experience is negligible for these persons in the higher amount of swimming groups.

These adjusted percentages show similar inconsistencies to those noted in Table 5 for the unadjusted percentages.

TABLE 6 - ADJUSTED PERCENTAGE OF PERSON-DAYS WITH REPORTED ILLNESS BY AREA, SEX AND SWIMMING FREQUENCY (NON-CHRONIC AILMENT PERSONS UNDER 65 YEARS ONLY)

Group	Swimming Frequency - Days				Number of Persons in Group
	0	1-9	10-24	Over 24	
North Beach - Males	1.41	2.49	3.62	2.19	973
South Beach - Males	3.38	3.21	2.69	2.62	967
North Beach - Females	2.24	4.23	3.10	2.96	1048
South Beach - Females	3.57	3.65	4.51	1.66	1042

(1) The process used is not described in detail in this report, but is that known as the "direct method" in computing age-adjusted death rates. The distribution by age of all person-days (exclusive of "over 64 years" and "age not stated") for the entire surveyed population was used as the standard distribution.

The percentage of person-days on which illness was reported (which is a measure of the prevalence of illness) was generally higher among persons who did a moderate amount of swimming than among non-swimmers. This result was to be expected, as past experience has indicated that even if the water were without any demonstrable pollution, the amount of minor illness might be positively associated with the amount of swimming done. However, since illness prevalence is heavily weighted by illness of long duration, it is not as sensitive to environmental influences as is the incidence of illness. This latter measure will be discussed later.

These variations in the amount of illness with the amount of swimming suggest that the illness among non-swimmers might be taken as a norm against which to compare the swimming groups. This technique can be used to make allowance for the apparently higher basic prevalence of illness in the families of the South area. Table 7 was prepared from the data of Table 6 to show the ratio of illness prevalence in the various swimming classifications to that of corresponding non-swimmers. The results appear to indicate that illness in the various swimming groups in the South area was low in relation to the corresponding categories in the North area, although it is not apparent whether this was due to a basically lower prevalence of illness among the swimmers or to an unduly high prevalence among the non-swimmers.

TABLE 7 - RATIO OF ILLNESS PREVALENCE IN VARIOUS SWIMMING CLASSIFICATIONS

Group	Swimming Frequency - Days			
	0	1-9	10-24	Over 24
North Beach - Males	1.00	1.77	2.57	1.55
South Beach - Males	1.00	0.95	0.80	0.78
North Beach - Females	1.00	1.89	1.38	1.32
South Beach - Females	1.00	1.02	1.26	0.46

B. Method 1 (Incidence)

It is apparent that the analysis in terms of prevalence of illness (or numbers of days of illness) for the two areas does not show correlation with the difference in the median bacterial quality of the waters. Therefore, a second approach was attempted, namely, to determine if the number of separate illnesses per 1,000 person-days (or the incidence of illness) showed any difference between the two areas and if an analysis of incidence of various types of illness would reveal any detrimental effect from swimming in the slightly poorer quality of water at South Beach.

Table 8 shows the number of separate illnesses by various type classifications in the two study areas that were recorded during the survey. Persons with chronic illness conditions have been included and classification by sex groups discarded to avoid excessively small classes. This information is shown in detail by age groups in Appendix D, Table 3.

TABLE 8 - NUMBER OF RECORDED ILLNESSES BY TYPE AND AREA

Area	Type of Illness						
	All Types	Nose and Throat	Gastro-intes-tinal	Skin	Eye or Ear	Eye or Ear and Nose	Other
North Beach	1,103	601	214	104	100	11	73
South Beach	1,134	591	205	95	117	19	107

Approximately one-half of the illnesses in each area were respiratory and about one-fifth were gastrointestinal. Skin rashes and infections comprised about one-tenth of the illnesses as did eye and ear diseases. A check based on a sample of the records showed that only a small proportion of the illnesses, approximately 15 per cent, had a duration in excess of one week.

Table 9 shows the number of illnesses per 1,000 person-days for four broad categories of illness type by broad age groups and for the two study areas. A breakdown of this information for the various specific age groups is given in Appendix D, Table 4.

TABLE 9 - RECORDED ILLNESSES PER 1,000 PERSON-DAYS BY TYPE, AREA AND AGE GROUP

Area and Age Group	Type of Illness				
	All Types	Nose and Throat	Gastro-intestinal	Skin	Eye, Ear and Other
North Beach:					
Under 10 years	13.1	7.0	2.3	1.4	2.4
10 Years and Over	5.9	3.2	1.2	0.5	0.9
All Ages	7.0	3.7	1.4	0.7	1.2
South Beach:					
Under 10 years	12.7	6.4	2.0	1.4	2.0
10 Years and Over	7.1	3.8	1.4	0.5	1.5
All Ages	8.3	4.3	1.5	0.7	1.8

The age groups 10 years of age and over did approximately 80 per cent of the swimming in both the North and South Beach areas, and for these groups the incidence of illness was somewhat higher for the South area for all classes of illness except skin rashes and infections. For the age groups under ten years, a contrary trend is evident.

The data on incidence of illness has been analyzed in the same manner as for the prevalence of illness. Illness incidence rates for all ages, adjusted in the same manner as previously described, grouped by area and swimming frequency, are given in Table 10. The breakdown of these data by age groups is given in Appendix D, Table 5.

TABLE 10 - ADJUSTED ILLNESS INCIDENCE RATES PER 1,000 PERSON-DAYS
(Persons 0-64 years old only)

Group	Swimming Frequency - Days			
	0	1-9	10-24	Over 24
North Beach both sexes	4.04	8.75	9.42	10.60
South Beach both sexes	6.62	9.22	9.75	8.19

Using the illness incidence rate among non-swimmers as a norm, Table 11 has been prepared to show the ratio, for several types of illness, of the illness incidence for the different swimming groups to that for non-swimmers.

TABLE 11 - RATIO OF ILLNESS INCIDENCE OF SWIMMERS TO NON-SWIMMERS BY ILLNESS TYPE, SWIMMING FREQUENCY AND AREA

Area Group	Swimming Frequency - Days			
	0	1-9	10-24	Over 24
All Illnesses				
North Beach - Both sexes	1.00	2.17	2.33	2.62
South Beach - Both sexes	1.00	1.39	1.47	1.24
Nose and Throat				
North Beach - both sexes	1.00	2.21	2.51	2.43
South Beach - both sexes	1.00	1.37	1.25	1.21
Gastro-intestinal				
North Beach - both sexes	1.00	1.71	1.78	2.51
South Beach - both sexes	1.00	0.85	1.04	0.69
Other Types of Illness				
North Beach - both sexes	1.00	2.42	2.43	3.13
South Beach - both sexes	1.00	2.15	2.61	2.02

In the group of non-swimmers the excess of illness incidence in the South area was very pronounced which corresponds to the increase in illness prevalence shown in Table 6. Consideration of the ratios of adjusted incidence rates of swimming to non-swimming groups for the various categories of disease indicates

that within the parameters of bacterial quality of water in the two areas there is no indication that the higher coliform density on the South Beach during the period of the survey caused any increased incidence of illness for the swimmers of the South area.

C. Method 2

The second major method of analysis was a comparison of illness experienced in the week following swimming on three days of high coliform densities with that following swimming on three days of low coliform densities.

Table 12 shows the number of persons swimming at the two neighborhood beaches on each of six specified days. These days were selected as described on page 24 in Section IIE to provide three days of high coliform densities and three days of low coliform densities common to both beaches. The number and percentage of the swimmers who reported an illness in the following week are shown in the third and fourth column.

TABLE 12 - ILLNESS INCIDENCE RATES FOLLOWING SWIMMING ON DAYS OF HIGH AND LOW COLIFORM DENSITY

Coliform Density Classification	Date	Mean Coliform Density MPN/100 ml	Number of Persons Swimming at Neighborhood beach	Number of Swimmers Reporting Illness During Subsequent Week	Illness Incidence Rate Per 100 Swimmers	3-day Illness Incidence Rate
		NORTH BEACH - BOTH SEXES				
High	7/13	1980	199	17	8.5	
High	7/15	430	195	27	13.8	9.86
High	7/23	460	164	11	6.7	
Low	7/30	28	254	12	4.7	
Low	8/12	31	177	29	16.4	8.65
Low	8/24	36	401	31	7.7	
		SOUTH BEACH - BOTH SEXES				
High	7/13	5680	182	17	9.3	
High	7/15	900	192	42	12.5	12.19
High	7/23	2470	192	28	14.6	
Low	7/30	76	273	19	7.0	
Low	8/12	29	200	17	8.5	8.48
Low	8/24	36	459	43	9.4	

Consideration of the three-day incidence rate for illnesses within a week subsequent to swimming indicates that swimming at the time of high coliform density might cause more illness than swimming at times of low coliform density.

In the case of swimmers at the North Beach the difference is not great enough to rule out the possibility that it may have resulted from chance, but at the South Beach area the difference is one which could occur as a result of chance but once in fifty trials.

This evidence from the results of "high" and "low" days, however, is not conclusive. There were only three days on each side of the comparison and there is, therefore, insufficient evidence to permit an analysis of the effect that weather might have on the result. In hot weather many more people go swimming, many of whom swim only on very hot days. These occasional bathers may have a characteristically different illness incidence rate than those who are frequent swimmers. In order to control this variable of the weather, it is necessary to have a large enough number of days that differences in weather tend to balance for the "high" and "low" days, or, preferably, that sufficient data are available to permit holding one or more weather variables constant in making the comparison.

In view of the foregoing discussion, it is of interest to compare certain weather variables for the various days of "high" and "low" coliform density. This is done in Table 13 showing data from the Chicago Weather Bureau Office.

TABLE 13 - WEATHER VARIANTS ON SELECTED DAYS OF HIGH AND LOW COLIFORM DENSITY

Coliform Density Classification	Date	Reported Swimmers at Neighborhood Beaches	Weather Data			
			Temp °F		Percent Possible Sunshine	Precipitation Inches
			Max.	Mean		
High	7/13	381	80	75	53	0
High	7/15	387	80	73	35	0
High	7/23	356	73	66	19	Trace
Low	7/30	527	83	74	84	0.02
Low	8/12	377	86	75	94	0
Low	8/24	860	98	84	100	0

These data show that for these particular days, the weather was generally warmer and sunnier and that more people went swimming on the days of low than those of high coliform density.

Method 3

The final method for analysis was based upon the number of people having an onset of an illness a specified number of days after swimming and the comparative coliform density of the beach water on the day when the swimming occurred.

For Table 14, the days for which bacteriological results were available at one or both of the beaches were arranged in order of magnitude of the coliform densities reported on each day at each beach. Then these beach-days were divided into six "sextiles" with an equal number of beach-days in each "sextile," the one-sixth of the days having the highest coliform densities being in the first sextile, the next lowest one-sixth in the second sextile, and so forth. Opposite each of these sextiles are entered the numbers of persons who had an

onset of illness at specified time intervals after swimming on any day with a coliform density within the particular sextile.

TABLE 14 - NUMBER OF SWIMMERS REPORTING ILLNESS GROUPED BY COLIFORM DENSITY OF SWIMMING WATER AND TIME INTERVAL TO ILLNESS ONSET

Sextile of Days by Coliform Density Level	Number of Swimmers with Illness Onset "X" Days after Swimming			
	"X" = 0	"X" = 1	"X" = 2 *	"X" = 3*
Highest	40	48	48	23
2nd	39	45	24	33
3rd	38	30	23	28
4th	55	83	35	39
5th	46	34	36	38
Lowest	62	53	31	22
Totals	280	293	197	183

* Numbers of persons in these columns are estimated.
On code sheet (Appendix C) these columns are combined.

As there are an equal number of days in each sextile, it would be expected, if the pollution of the water had no effect, that equal numbers of people swimming on a day occurring in any of the sextiles would become ill at any given interval after swimming. If, however, the degree of water pollution was a factor, a greater number probably would become ill at a given interval after swimming on a day that was in a "high" coliform density sextile than after swimming on a day occurring in a low density sextile. It is evident from Table 14 that, within the limits of densities normally found at these

beaches, no particular correlation exists between the number of persons falling ill a specified number of days after swimming and the coliform density of the water on the day of swimming.

IV. DISCUSSION

A. As is shown in Table 1 at a given sample point there were variations in the coliform M.P.N. from day to day. These variations were greater than would have occurred in replicate portions taken from a water of uniform quality.

An example of this is shown by the results for Sample Point 25 on the South Beach. At this point the 35 routine samples collected from July 8 to August 28 had coliform most probable numbers varying from 23 to 4,600. In spite of this wide variation, the median value was 230 and 80 per cent of the results were under 500.

These variations found in the beach waters indicate the fallacy of attempting to rate bathing waters on the basis of a very few samples. Also they would show that any standard for bacterial quality of bathing waters should be based on the mean results of an adequate number of samples, with a permissible percentage in excess of a specified value, rather than on the rigid basis of an absolute maximum which may not be exceeded.

B. The calendar type of household record to be filled out daily by the householder proved to be a very satisfactory method of gathering data from a large study population with a minimum of field investigators. Undoubtedly, there were inaccuracies in the records and it was evident that entries were not always made daily as was desired. However, if it had been possible to have had sufficient workers to visit each cooperating household weekly, many families would have been missed on one or more weeks and reliance would have been placed on the memory of the householder to complete the data on a subse-

quent visit. In general, the forms showed evidence that they had been carefully completed and that excellent cooperation was obtained from most families. It was gratifying to learn that a method which could be handled by a limited staff could provide a reasonably reliable record of illness and swimming during the summer.

C. Based on the results of beach water samples taken by the Chicago Park Board during the 1947 bathing season, it was anticipated that there would be an appreciable difference in water quality in the North and South Beach study areas, with the waters of the South Beach having about five times the coliform density of the North Beach water. The study was predicated on this anticipated difference to obtain the illness experience of a group bathing in a water of low coliform density contrasted with that of a group bathing in water with a moderately high coliform density. The intensive sampling program of 1948 showed that the difference in water quality was much less than had been anticipated. The summarized data of Table 1 shows that the South Beach water had about twice the coliform density of the water at the North Beach and that the general quality of the water in both areas was very good for shore waters of a large lake in the immediate vicinity of a heavily populated area.

D. Illness data were analyzed in various ways in an attempt to correlate illness with exposure to bathing waters of varying coliform densities. When the data were tabulated to show prevalence of illness (number of days of illness) in the two areas by age, sex and frequency of swimming, there was no evidence that the higher coliform densities of the bathing waters at the South Beach were reflected in higher illness rates among those who swam there. A similar attempt was made to determine if the number of separate illnesses per 1,000 person-days (the incidence of illness) bore any relation to the differ-

ence in water quality. No relation could be established between the total incidence of illness nor the incidence of illness of any particular type and the general water quality in the two areas.

Two other methods were attempted to establish a correlation between illness and water quality. In the first, three days of relatively high and three days of low coliform densities were selected that were known to be common to both beaches. The illnesses occurring within a week following swimming on these selected days were tabulated. This method of analysis showed definite evidence of higher illness incidence following swimming on the days of high coliform density and was the only method of analysis that offered any suggestion of a positive result.

The last method of analysis divided all days for which bacteriological results were available for one or both beaches into sextiles in order of magnitude of the coliform densities on each day at each beach. For each sextile there was noted the number of persons who had an onset of illness at specified time intervals within three days after swimming on a beach-day included in the sextile. It would be anticipated that if a marked increase in illness incidence followed swimming on days of relatively high coliform densities, the highest sextile should show the greatest incidence of illness. No such correlation was found.

This lack of correlation apparently refutes the evidence presented by the previous analysis based on "high" and "low" days. This, however, may be due to the fact that only three high and three low days were selected and, hence, there was insufficient evidence to eliminate the effects of weather variables.

V. GENERAL CONCLUSIONS

1. Bathing in Lake Michigan shore waters with a median coliform density of 180 per 100 ml. presents no general hazard to public health.

2. Further studies are necessary to determine the ranges of water quality which may be correlated with definite illness hazards to bathers.

3. Bathing water quality evaluation must be based upon adequate sampling and bacteriological examination to obtain an understanding of the fluctuations in water quality as well as the average quality of the water over a period of time.

4. The use of a household record maintained on a calendar type form was highly satisfactory for this type of study.

5. The interest of the participating population groups was excellent as indicated by the return of 78 per cent of the completed calendar forms at the end of the survey.

6. The method of statistical analysis based on the comparison of illness experienced within a week following swimming on days of markedly varying bacterial quality of the water appears to be the most satisfactory from the standpoint of indicating the possible effects of water quality on health.

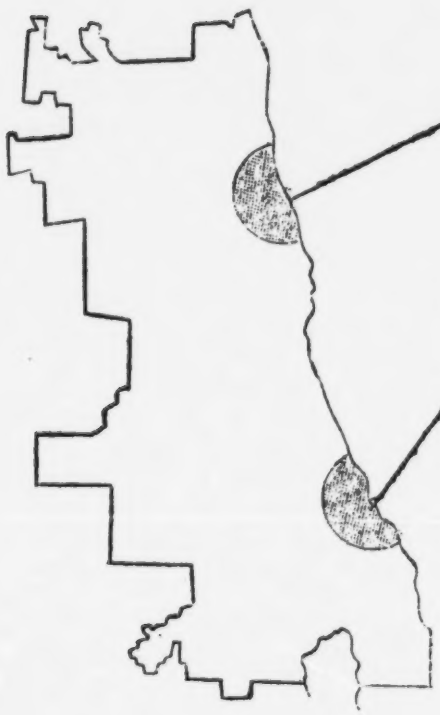
APPENDIXES

APPENDIX A

Epidemiological Field Forms

HELP!

ooo1000 FAMILIES FROM THE NORTH AND SOUTH SIDE AREAS NEEDED IN LAKE MICHIGAN BATHING WATER SURVEY



TOUHY TO LOYOLA AVE.
LAKE MICHIGAN TO ELEVATED TRACKS

71st TO 77th STREET
LAKE MICHIGAN TO ONE BLOCK
WEST OF EXCHANGE AVE.

WHAT EFFECT DOES LAKE WATER HAVE UPON THE HEALTH OF THE BATHER?

FOR THE FIRST TIME IN MEDICAL HISTORY A COMPREHENSIVE SURVEY TO DETERMINE WHETHER OR NOT CERTAIN ILLNESSES OR IRRITATIONS MIGHT BE CAUSED BY BATHING IS BEING UNDERTAKEN. YOUR COOPERATION WILL HELP NATIONAL, STATE AND LOCAL HEALTH AGENCIES IN THEIR ATTEMPT TO FIND AN ANSWER TO THIS PROBLEM.

A NURSE OR MEDICAL STUDENT WILL CALL AT YOUR HOME WITHIN THE NEXT FEW DAYS TO EXPLAIN THE SURVEY. THIS PROJECT DESERVES YOUR SUPPORT.

* * * * * * * * *

(Sponsored by: local governmental health agencies in cooperation with Illinois, Indiana and Wisconsin State Health Departments.)

BATHING WATER SURVEY COMMITTEE

Instructions to Investigators

Each household unit visited should be furnished with a calendar form and a mimeographed letter "Dear Participant." The general purpose of the survey should be explained and the method of filling out the calendar form should be described in detail with illustrations.

The following information should be secured at the time of the visit and it should be entered on the calendar form:

Family Name - last name of head of household.

Address and Telephone - the street and number, postal zone, apartment number, and telephone number.

Members of Household - the first and middle name (or initial) of the head of the household should be recorded first. Each member of the household having the same last name as the head of the household should be listed in a similar manner. The full names, including last name, of other members of the household should be entered.

Example:
Family Name - Brown
Members of Household - John E.
Mary B.
(Mrs.) Margaret F. Jones

Age - The age in years to the nearest birthday. If the household occupants in the older age groups do not wish to state their exact ages they may be recorded as ">40" or ">50."

Sex - Use the appropriate first letter to denote male or female.

Relationship - opposite the name of each member of the household, his or her relationship to the "head" or first person listed should be noted as follows:

Wife, son, daughter, (including stepson or stepdaughter), father, mother (including in-laws), brother, or sister (including in-laws). All other members of the household should be designated "none" regardless of relationship.

Chronic Illness - the interviewer should determine whether or not there is any history of chronic illness in any member of the family. This should be recorded opposite the individual affected in accordance with the following code:

E - chronic eye infection
R - chronic ear infection
N - chronic sinusitis, hay fever, other nasal allergy
T - chronic bronchitis
S - chronic skin allergy
G - chronic gastrointestinal infection
A - chronic asthma

Entries - actual entries should be made on the calendar form starting with June 28 on the basis of information supplied by the householder at the time of the first visit.

First Name - the first name of each member of the household should be entered in the same order in the second bank of the calendar.

Thumb Tacks - should be provided, if necessary, and it would be best if the calendar could be placed on a wall at the time of the first visit.

Office Record - the information contained on the office record card should be filled in before leaving the calendar form. The date of the visit should be recorded in the upper left hand box.

Scheduled Absence - if the members of the household plan to be absent for a period of 10 days or more. The dates of such scheduled absence should be noted on the office record card.

OFFICE RECORD

File No.

Address _____ _____ _____
No. Street Zone Apt. No.

Head of Household _____ _____
Last Name First Name Initial

Number in Household _____ Telephone No. _____

DATES COVERED

Visit											
Telephone											
Circular											

Scheduled Absence _____

File No. _____

LAKE MICHIGAN BATHING WATER SURVEY

Family Name _____ Tel. No. _____ _____

Address _____ _____ _____ _____
No. Street Zone Apt. No.

Notes 1. For further explanation of any entry use the back of this form. Put a footnote number on the front next to the entry and also on the back next to explanation.

2. If you move away or if this calendar is not called for by Sept. 15, please mail it to Mr. R.S.Smith, 425 E.14th Boulevard, Chicago, Illinois.

3. For further information telephone Harrison 5255

No	Members of Household	Age	Sex	Relationship	Chronic Illness	Record	June 28	29	30	July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1				Head		Swim																											
						Illness																											
2						Swim																											
						Illness																											
3						Swim																											
						Illness																											
4						Swim																											
						Illness																											
5						Swim																											
						Illness																											
6						Swim																											
						Illness																											

No.	First Name	Record	July 25	26	27	28	29	30	31	August 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	September 1	2	3	4	5	6	7
1		Swim																																												
		Illness																																												
2		Swim																																												
		Illness																																												
3		Swim																																												
		Illness																																												
4		Swim																																												
		Illness																																												
5		Swim																																												
		Illness																																												
6		Swim																																												
		Illness																																												

Make some entry on swimming and on illness for every day for each member of the family as follows:

Swimming

- x No swimming
- S1 swimming in Lake Michigan at neighborhood beach, in water for less than 30 minutes.
- S2 swimming in Lake Michigan at neighborhood beach, in water for thirty minutes or more.
- O swimming at any other location.
- – out of town for more than 3 consecutive days.

Put down whether there was any swimming or not for every day, not just for days there was some illness.

Illness

- X No illness of any kinds listed below.
- E Eye inflamation, styes, watery eyes.
- R Ear infection, earache, or any other trouble with ears.
- N Nose or head cold, sinus trouble, persistent stopped-up nose.
- T Throat inflammation, sore throat, persistent cough.
- S Skin infection, skin rash, open sores, itching.
- G Stomach or intestinal upset, diarrhea, vomiting, nausea.
- – Out of town for more than 3 consecutive days.

Put down any illness of the types given in the list even if you don't think it was connected with swimming.

BATHING WATER SURVEY COMMITTEE
425 East 14th Boulevard
Chicago, Illinois

Dear Participant:

The purpose of this survey is to secure reliable information on the physical effects to human beings, if any, of swimming in Lake Michigan. To accomplish this two items are especially important. First, a sufficiently large population group must be surveyed to give significant results; and second, the entries on the calendar form by the householder must be carefully made each day.

We have selected the area in which you reside because it was felt that the type and size of the resident population fitted these two requirements in the Chicago area. Your cooperation in maintaining an accurate record on the calendar form is urgently requested.

The following explanations are made for your guidance in using the calendar:

Entries. An entry should be made opposite "swim" and "Illness" for each member of the household for each day. The letter symbols shown at the bottom of the form should be used in making the entries in the appropriate blocks. For example:

Swim	x	x	S1	x	o	x	x	S2	-	-	-	-	x
Illness	x	x	x	x	x	E	E	x	-	-	-	-	R

Out of Town. If any member of the household is out of the city or living in some other area of the city for more than three (3) consecutive days, dash lines (-) should be placed opposite his name for each day in both the "swim" and "illness" lines.

Swimming Record. When a member of the household visits a beach for purposes of picnicking, sunbathing, playing beach games, etc., but does not go in the water, the entry for the day should be (X), meaning no swimming.

Swimming includes diving, wading, or any other activity in which the participant is actually in the water. However, this does not include the normal bathing in one's home.

Neighborhood Beach. This means any point along the Lake Michigan shore line within 1/2 mile of your residence.

Illness Record. If any ailment persists for several days, the appropriate symbol should be entered in the "illness" line for each day. Also if a person has more than one of the ailments listed, two entries should be made in the "illness" block for that day or an explanation can be made on the back of the form with an appropriate foot note.

From time to time we shall try to reach you by telephone or by another visit. However, we sincerely urge you to maintain a complete and accurate record on the calendar form provided. If any questions arise will you please call Harrison 5255 between the hours of 5:30 p.m. and 8:30 p.m. Your cooperation and assistance in making this survey is greatly appreciated.

Sincerely yours,

The Bathing Water Survey Committee
in cooperation with
Chicago Board of Health
Cook County Department of Public Health
Chicago Park District
Illinois Department of Public Health

BATHING WATER SURVEY COMMITTEE

425 East 14th Boulevard

CHICAGO, ILLINOIS

A field worker from the Bathing Water Survey Committee called on you to collect the record form that you have been keeping for us, and unfortunately was unable to find you at home.

It is essential to this study that these records be completed and returned without delay so that the information may be tabulated for study.

Will you please see that your record is completed and then put in the attached stamped envelope and mailed at once?

Again we wish to thank you for the help that you have given to this work during the summer.

Sincerely yours,

BATHING WATER SURVEY COMMITTEE.

RSS/ecf

APPENDIX B

Bacteriological Survey Forms

TRI-STATE SURVEY OF LAKE MICHIGAN WATERS

"Instructions for Sample Collectors"

1. Find sample point and range.

2. Mark bottle with sample point number and date.

3. Fill out sample card. Be certain that all information concerning sample point number, date, time, lake condition, weather, bathing load and temperature is complete.

   Lake condition is to be entered as "calm," "rough" or "heavy surf." If the lake surface is practically smooth or with no more than a very occasional whitecap showing, it is to be called "calm." If the lake is choppy with many whitecaps in evidence, but the waves breaking on the beach are irregular and less than three feet high, the lake is to be called "rough." If a regular, well formed, series of waves over three feet high are breaking on the beach, the condition is to be called "heavy surf."

   Weather is to be described as "fair" - "cloudy" - "rain" or "fog" in the customary sense of these terms.

   Bathing Load. Count the number of people actually in the water along 200 feet of shoreline at the sampling point and enter this figure. Count people wading, playing, swimming. Do not count people that are not actually in the water.

   Temperature - Air - water. Record results to the nearest degree. It will be found advisable to read air temperature first. In making reading of water temperature, be certain to keep thermometer immersed long enough so that mercury will have time to drop to full estent.

   Remarks. If any unusual condition is noted, put a check after "Remarks" and enter notes on back ofcard. In sampling at outlet of yacht harbors, make rough count or estimate of number of cabin boats in harbor and enter under remarks. Note presence of visible oil, industrial waste, organic matter, etc.

   Initial - Place your initials in upper right corner of sample card.

4. Taking sample.

   Loosen protective hood over bottle top. Grasp stopper thru protective hood with one hand and bottle with other. Remove stopper, taking care that fingers do not touch mouth of bottle. Sample by immersing bottle neck first with sweeping motion to depth of about six to nine inches. When bottle is full, remove from water, replace stopper and refasten hood. Place sample in ice box at once. If sampling from bridge or boat where use of special sampling device is necessary, do not remove stopper until bottle is fastened in sampler, and sample is ready to be taken. Be careful not to touch mouth of bottle.

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U.S.P.H.S.

A. C.

TRI-STATE SURVEY OF LAKE MICHIGAN WATERS
SAMPLE-LABORATORY RECORD

Laboratory _____
Sample Point S-2
Date 7/13
Time 10:45

Temp. deg. F.
Air ~~X~~ 80
Water 70
Turbidity 25

Lake Condition calm
Weather cloudy
Bathing Load 0

Coliforms												
1			1/10			1/100			1/1000			Dilutions
+	+	+	+	+	−	−	−	−	0	0	0	Lactose 24 hrs.
/	/	/	/	/	+	−	−	−	−	0	−	Lactose 48 hrs.
C	C	C	C	C	C							B G B

Enterococci												
10			1			1/10						Dilutions
+	+	+	0	−	−	0	0	0				Presumptive
C	N	C										Confirmed

MPN - Coliform 2400 Enterococci 9.1

Coding: Lake Condition: Calm - Rough - Heavy Surf
Weather: Fair - Cloudy - Rain - Fog
Bathing Load: No. people in water in 200 foot frontage at sample point
Remarks? _____

1948 JUL 13 PM 4 18

56

Lake Conditions: Calm - Rough - Heavy Surf
Weather: Fair - Cloudy - Rain - Fog
Bathing Load: Number of people in water on 200 feet of shore line

TRI - STATE SURVEY OF LAKE MICHIGAN WATERS

Sample Point No.-----

City ---------- County -------- State --------

Presumptive	Confirmed
No. + in 5 tubes (in pencil)	No. + in 5 tubes (in ink)

6/1/46

Laboratory ----------

Date	Collected by	Time	Prevailing Winds: Direct.	Prevailing Winds: M.P.H.	Weather	Turbidity p.p.m.	Lake Cond.	Temp. F: Water	Temp. F: Air	Bathing Load	PH	Group	Bacteriological Results: Size of Portions - ml. 10	1.0	0.1	.01	.001	MPN/100 ml.: Colif.	MPN/100 ml.: Entero.	Remarks
												Colif. / entero.						xxxx / xxxx	xxxx	
												colif. / entero.						xxxx / xxxx	xxxx	
												colif. / entero						xxxx / xxxx	xxxx	
												colif. / entero.						xxxx / xxxx	xxxx	
												colif. / entero						xxxx / xxxx	xxxx	
												colif. / entero.						xxxx / xxxx	xxxx	
												colif. / entero.						xxxx / xxxx	xxxx	
												olif. / entero.						xxxx / xxxx	xxxx	
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												colif. / entero.						xxxx / xxxx	xxxx	

U.S.P.H.S.

SAMPLE POINT DESCRIPTION

Sample Point	Description
	North Beach
9	Loyola Park Beach. Sample point is at end of Greenleaf Ave. and is on range of the north face of apartment buildings on the south side of Greenleaf Ave.
S2	Pratt Blvd. street end. Sample point is opposite the foot of the steps to the beach.
S3	Albion Ave. street end. Sample point is at middle of beach to the south of the center line of Albion Ave. and is approximately 100 ft. north of apartment house retaining wall.
	South Beach
S4	Private beach just north of 73rd St. Sample point is on range of wire fencing on south line of emergency housing units (midway between 72nd Place and 73rd Street).
S5	74th Street. Sample is on range of north wall of single story white building on south side of 74th St. and 2x8 post on beach (approximately 75 ft. south of concrete wall).
24A	Rainbow Beach, North End. Sample point is on range of south edge of Gate 3 and tall steel stack on apartment building and is about midway between lifeguard tower and north breakwater.
25	Rainbow Beach, South End. Sample point is on range of the northeast corner of the center light tower and a cross on church spire (Approximately on line from center of tower to intake crib).

APPENDIX C

Statistical Codes and Code Sheets

Special Coding Instructions for Lake Michigan Bathing Water Survey Schedules

Schedules to be excluded from coding

If there is no person in the household for whom more than a week's experience has been recorded, the schedule should be pulled out and not coded.

Individuals to be excluded from coding

If there is a person in the household for whom no more than a week's experience is recorded or if there is a name that has obviously been added to the roster by the family (in cases of doubt compare number of names listed with "No. in household" on office record card), then no information should be coded for this person.

File No. (Family)

Occasionally a family file number will be given as 689A, for example. The punch card will have only four columns for family file numbers (which run up to 1600 or so), hence, it will be necessary to assign a new family file number in case a letter has been added. The coder should scratch out the 689A and substitute the nearest unused family file number.

Age:

In case the age of an individual is not stated or is stated as "over 21," or "over 30," for example, the coder should estimate the age by looking at the column entitled "Relationship." Use the age of the husband less 2 years if the individual is a "wife." Use the age of the oldest child present in the family plus 20 years if you don't have a husband's age to go on. Thus, if there is a "husband," "wife," and "grandmother" listed for the family and the grandmother's age is given as "over 45," substitute the age of the husband plus 20 years. (Use the husband's age rather than the wife's because it is probably more accurately stated). If neither of these rules can be applied, consult the statistician in charge. Do not code any age as "unknown or not recorded" without consulting the statistician, as it is usually possible to estimate it closely enough for practical purposes.

Sex

If sex is not reported, the coder should guess at the sex on the basis of either the relationship or the given name. Do not code the sex of any individual as "Not recorded" without consulting the statistician in charge.

Chronic Illness

In case an O is found in the Chronic Illness column, this should be coded as X. Two combinations of types of chronic illness are provided for in the code (N & T takes code 7 and A & N takes code 8). All other combinations should be coded 9.

Days of Record

The instructions on the schedule called for the use of dashes when an individual was to be out of town for "more than 3 consecutive days." If 3 or less dashes are shown consecutively through a misunderstanding of the instructions, then these days should not be counted as "out-of-town" days and they should be included in the count of days of record.

If more than 3 consecutive dashes are shown on the swimming line but not on the illness line, it will be assumed that the person was out of town and the experience for those days will not be counted even if some illness is shown on the illness line for those days.

Dates left blank (without either an X or a -) will be counted as days of record on the assumption that the family simply did no swimming and had no illness during that period and did not realize they were supposed to fill in with X's. Exception: If the blank dates occur either at the beginning of the recorded experience (i. e., before any symbols of any sort have been recorded) or at the end of the recorded experience (i.e., after the last recorded symbol of any sort), then these blank days will not be included in the days of record.

Dates covered by big X's (X-ing out several days and lines at a time) are counted as days of record in which there was no swimming and no illness.

The code for Unknown days of record should not be used without consulting the statistician in charge.

Remember that the objective of the days of record code is to find how many days (in the interval between the day the schedule was left and the day it was picked up) each individual was in town plus the days he was out of town for 3 consecutive days or less.

Swimming Experience

In cases where S1 and O, or S2 and O, appear in the same box, code the S swimming only. (This happens only infrequently in the schedules that have been inspected).

If O swimming (i.e., swimming elsewhere) is found with dashes in the days on either side of it, indicating that the person may have been

out of town for more than 3 consecutive days (including the 0 day or days) at the time the 0 swimming occurred, then this swimming should not be coded at all and all days should be considered as "out-of-town days."

If it is stated on the schedule that swimming was done at such-and-such a street or place, consult the map to see whether this swimming should be considered as S swimming or 0 swimming.

If S swimming is recorded but is not specified as S1 or S2 swimming, count it as S2 swimming.

Illness Record

If an illness starts out with one code letter and, before its end, changes to another code letter, or if a single box has more than one illness code letter, use the appropriate code for a combination type of illness. If there is no code for the particular combination that occurs, use code 9 which includes "other combinations." Note that there are also combination codes for certain combinations of chronic illnesses.

In case more than 5 illnesses are reported for any one individual, code the first five in chronological order into the five illness fields shown on the code sheet, but be sure to include the total number of days of all illnesses in Columns 29 and 30.

The first column of each of the five illness fields is the Illness Type column (Cols. 31, 40, 49, 58, 67). An X code in this column indicates the end of the coding for that person. Thus, if the person had:

no	illnesses	there would be an X in	Col. 31
1	illness	"	Col. 40
2	illnesses	"	Col. 49
3	illnesses	"	Col. 58
4	illnesses	"	Col. 67

It is not necessary to put an X in Col. 76 if the person had 5 illnesses but, with this exception; Every line of coding will end with an X, and every column to the left of this X should have some code in it.

Footnotes

It is especially important to watch out for footnotes on the back of the schedule and also notes that have been made on the Office Record Card which is attached to each schedule. These notes will often help to explain peculiarities in the filling out of the schedule.

Codes for Lake Michigan Bathing Water Survey Schedule

I. Personal Particulars

Col. 1. Area (North or South)

Code: 1 = North
2 = South

Cols. 2-5. File No. (Family)

Code: Transfer from schedule. (Code File No. 1 as 0001, etc.)

Col. 6. Individual No. (Line No.)

Code: Transfer from schedule.

Cols. 7-8. Age

Code: XX = Unknown or not recorded
00 = Under 1 yr. (to last birthday)
01 = 1 year "
02 = 2 years "
.
.
99 = 99 years and over "

Col. 9. Sex

Code: 0 = Not recorded
1 = Male
2 = Female

Col. 10. Chronic Illness

Code:

0 or blank - no chronic illness recorded	= X
E - chronic eye infection	= 0
R - chronic ear infection	= 1
N - chronic sinusitis, hay fever, other nasal allergy	= 2
T - chronic bronchitis	= 3
S - chronic skin allergy	= 4
G - chronic gastrointestinal infection	= 5
A - chronic asthma	= 6
N & T - combination of N and T	= 7
A & N - combination of A and N	= 8
Other type or other combination	= 9

I. Personal Particulars (continued)

Cols. 11-12. Days of record (exclude out of town)

Code: Count no. of days of record and record as 00, 01, 02, etc.
Unknown days of record = XX

II. Swimming Experience

Col. 13. Swimming on . . .

Code: 0 = swimming elsewhere (code 0 on schedule)
1 = swimming at neighborhood beach < 30 mins. (S1 on schedule)
2 = swimming at neighborhood beach 30+ mins. (S2 on schedule)
8 = no swimming (X on schedule)
9 = out of town (- on schedule)
X = No swimming - No illness entire survey

Col. 14. Swimming on . . .

Code: Same as for Col. 13

Col. 15. Swimming on . . .

Code: Same as for Col. 13

Col. 16. Swimming on . . .

Code: Same as for Col. 13

Col. 17. Swimming on . . .

Code: Same as for Col. 13

Col. 18. Swimming on . . .

Code: Same as for Col. 13

Cols. 19-20. Total days of S1 swimming

Code: Count total no. days S1 appears and record as 00, 01, 02, etc.
Unknown days of S1 swimming = XX

Cols. 21-22. Total days of S2 swimming

Code: Count total no. days S2 appears and record as 00, 01, 02, etc.
Unknown days of S2 swimming = XX

II. Swimming Experience (continued)

Cols. 23-24. Total days of S1 + S2 swimming

Code: Add total days of S1 and S2 swimming and record as 00, 01, 02, etc.

Unknown days of S1 + S2 swimming = XX

Cols. 25-26. Total days 0 swimming

Code: Count total no. days 0 appears and record as 00, 01, 02, etc.
Unknown days of 0 swimming = XX

Cols. 27-28. Total days of swimming

Code: Add total days of S1 and S2 and 0 swimming and record as 00, 01, 02, etc.

Unknown total days of swimming = XX

III. Total Days Ill

Cols. 29-30. Total days ill

Code: Count total days of E, R, N, T, S, and G illness and combinations of these (include any other footnoted illness; don't count any day of illness more than once); record as 00, 01, 02, etc.

Unknown total days of illness = XX

IV. Illness Record

(An illness is defined as a continuous period of days for which an illness symbol or a combination of symbols is recorded).

Cols. 31-39. First Illness

Col. 31. Type of Illness

Code:

No illness reported	= X
E - eye inflammation, etc.	= 0
R - ear infection, earache, etc.	= 1
N - nose or head cold, sinus, etc.	= 2
T - throat inflammation, sore throat, etc.	= 3
S - skin infection, skin rash, etc.	= 4
G - stomach or intestinal upset, etc.	= 5
N + T - combination of nose and throat	= 6
R + N - combination of ear and nose	= 7
E + N - combination of eye and nose	= 8
Other combinations and other types not elsewhere classified	= 9

Cols. 32-34. Date of onset

Code: Record first day of illness from schedule as follows:

July 8 = 708
Aug. 12 = 812
Aug. 31 = 831

etc.

Col. 35. Duration of illness

Code: Record length of illness in days as 1, 2, 3 . . . 8

9 = 9 days and over

Col. 36. Swimming on day of onset

Code:
0 = swimming elsewhere (Code 0 on schedule)
1 = swimming at neighborhood beach<30 mins. (S1 on schedule)
2 = swimming at neighborhood beach 30+ mins.(S2 on schedule)
8 = no swimming (X on schedule)
X = information not recorded

IV. Illness Record (continued)

Cols. 31-39. First Illness (continued)

Col. 37. Swimming on day prior to onset

Code: Same as for Col. 36.

Col. 38. Swimming on 2nd and 3rd days prior to onset

Code: 0 = swimming elsewhere only, on one or both days (code 0 on schedule)
1 = swimming at neighborhood beach<30 mins. only, on one or both days (code S1 on schedule)
2 = swimming at neighborhood beach 30+ mins. only, on one or both days (code S2 on schedule)
3 = swimming at neighborhood beach<30 mins. (S1) on one day and 30+ mins. (S2) on the other
8 = no swimming on either day (X on schedule for both days)
X = information not recorded

Col. 39. Swimming on 4th, 5th, 6th and 7th days prior to onset

Code: 0 = swimming elsewhere only, on one or more days (code 0 on schedule)
1 = swimming at neighborhood beach<30 mins. only, on one or more days (code S1 on schedule)
2 = swimming at neighborhood beach 30+ mins. only, on one or more days (code S2 on schedule)
3 = swimming at neighborhood beach<30 mins. on one or more days and 30+ mins. on one or more days but no swimming elsewhere (S1 and S2 but no 0 on schedule)
4 = swimming at neighborhood beach<30 mins. and/or 30+ mins. on one or more days and swimming elsewhere on one or more days (S1 and/or S2 with 0 on schedule)
8 = no swimming on any one of the four days (X on schedule for all four days)
X = information not recorded

IV. Illness Record (continued)

Cols. 40-48. Second Illness
Col. 40. Type of Illness
Cols. 41-43. Date of onset
Col. 44. Duration of illness
Col. 45. Swimming on day of onset
Col. 46. Swimming on day prior to onset
Col. 47. Swimming on 2nd and 3rd days prior to onset
Col. 48. Swimming on 4th, 5th, 6th, and 7th days prior to onset

All codes same as for Cols. 31-39

Cols. 49-57. Third Illness

Cols. 58-66. Fourth Illness

Cols. 67-75. Fifth Illness

All codes same as for Cols. 31-39.

Code Sheet for Lake Michigan Bathing Water Survey

| PERSONAL PARTICULARS | | | | | | | | | | | | SWIMMING EXPERIENCE | | | | | | | | | | | |

APPENDIX D

Detailed Tabulations of Epidemiological Data

TABLE 1 - PERCENTAGE OF TOTAL PERSON-DAYS WITH REPORTED NEIGHBORHOOD BEACH SWIMMING AND REPORTED ILLNESS

Age Group	No Chronic Illness				One or More Chronic Illnesses			
	North Beach		South Beach		North Beach		South Beach	
	Males	Females	Males	Females	Males	Females	Males	Females
Reported Neighborhood Beach Swimming								
Under 5 years	15.8	17.0	13.3	12.7	15.2	21.8	2.1	30.8
5 - 9 years	25.6	25.2	23.2	22.9	19.1	9.0	31.9	21.2
10-19 years	28.6	27.7	32.9	25.8	23.5	23.0	34.0	26.8
20-44 years	6.4	9.1	8.1	9.0	6.0	7.6	6.4	8.3
45-64 years	4.3	3.6	3.3	1.6	1.9	1.6	3.7	4.1
Over 64 years	0.4*	0.0*	0.7	0.1*	-	-	0.4*	-
Not Stated	1.7	2.2	8.1	8.9	16.3	5.3	-	-
All Ages	10.5	10.9	11.1	10.5	8.7	8.0	9.9	9.7
Reported Illness								
Under 5 years	5.3	5.2	5.3	5.9	10.4	7.1	3.5	6.0
5 - 9 years	4.2	6.0	6.3	5.9	6.8	1.4*	6.9	16.8
10-19 years	4.2	5.7	6.5	4.9	7.2	7.3	8.4	5.3
20-44 years	2.0	2.2	2.2	3.1	4.1	4.4	8.3	7.3
45-64 years	0.6	1.4	2.1	2.4	3.2	4.5	8.6	10.8
Over 64 years	-	4.2	0.4	4.5	1.7*	6.8	1.6	24.9
Not Stated	0.1*	1.1	2.3	4.2	7.3	1.8*	-	3.6*
All Ages	2.4	3.0	3.2	3.8	4.8	4.7	7.5	9.1

* Percentage based on less than 10 in numerator
\- Numerator was zero
0.0 Less than 0.05

TABLE 2 - PERCENT AGE OF PERSON-DAYS WITH REPORTED ILLNESS BY AREA, SEX, AGE AND SWIMMING FREQUENCY
(NON-CHRONIC AILMENT PERSONS ONLY)

Age Group	No Swimming			1-9 Days Swimming			10-24 Days Swimming			25 + Days Swimming			Number of Persons in Age Group
	Person Days	Illness Days	Percent	Person Days	Illness Days	Percent	Person Days	Illness Days	Percent	Person Days	Illness Days	Percent	
NORTH BEACH - MALES													
Under 5 years	2,762	129	4.7	2,925	140	4.8	1,773	115	6.5	1,325	81	6.1	149
5 - 9 years	60	-	0	1,725	64	3.7	1,816	91	5.0	701	28	3.6	78
10 - 19 years	769	7	0.9*	1,584	47	3.0	1,957	65	3.3	1,718	132	7.7	102
20 - 44 years	11,280	151	1.3	9,859	248	2.5	2,630	94	3.6	611	5	0.8*	402
45 - 64 years	10,366	59	0.6	2,771	18	0.6	562	10	1.8	500	-	0	242
Over 64 years	1,996	-	0	192	-	0	-	-	-	-	-	-	36
Age not stated	779	2	0.3*	364	-	0	-	-	-	-	-	-	24
All Ages	28,013	348	1.2	19,420	517	2.7	9,744	375	4.3	4,935	246	5.0	1,033
NORTH BEACH - FEMALES													
Under 5 years	1,888	48	2.4	2,330	178	7.6	1,999	90	4.5	1,041	63	6.0	124
5 - 9 years	146	-	0	1,343	98	7.3	1,943	130	6.7	743	23	3.1	72
10 - 19 years	525	47	9.0	1,745	135	7.7	2,178	109	5.0	1,441	46	3.2	107
20 - 44 years	13,807	205	1.5	10,357	282	2.7	4,424	142	3.2	1,626	49	3.0	514
45 - 64 years	10,605	141	1.3	2,325	61	3.0	670	-	0	359	4	1.1*	231
Over 64 years	2,901	126	4.2	38	-	0	-	-	-	-	-	-	50
Age not stated	1,575	22	1.4	395	-	0	-	-	-	72	-	0	34
All Ages	31,607	589	1.9	18,233	754	4.1	11,214	471	4.2	5,287	185	3.5	1,132
SOUTH BEACH - MALES													
Under 5 years	2,798	93	3.4	3,267	158	4.8	939	83	8.8	948	82	8.6	140
5 - 9 years	434	33	7.6	1,675	86	5.1	1,576	97	6.2	815	69	8.5	80
10 - 19 years	385	30	7.8	1,928	129	6.7	1,454	70	4.8	1,960	141	7.2	108
20 - 44 years	10,561	234	2.2	9,624	240	2.5	2,824	36	1.3	734	3	0.4*	431
45 - 64 years	9,218	221	2.4	1,623	26	1.6	587	1	0.2*	176	-	0	208
Over 64 years	2,621	12	0.5	276	2	0.7*	61	-	0	-	-	-	50
Age not stated	766	7	0.9*	677	22	3.2	238	10	4.2	-	-	-	31
All Ages	26,693	630	2.4	19,070	663	3.5	7,679	297	3.9	4,633	295	6.4	1,048
SOUTH BEACH - FEMALES													
Under 5 years	2,395	129	5.4	2,322	149	6.4	1,474	110	7.5	496	8	1.6*	124
5 - 9 years	592	22	3.7	1,773	106	6.0	2,474	177	7.2	695	23	3.3	102
10 - 19 years	737	51	6.9	2,038	79	3.9	1,769	67	3.8	1,314	88	6.7	110
20 - 44 years	12,466	365	2.9	9,739	313	3.2	3,772	150	4.0	1,106	12	1.1	500
45 - 64 years	10,257	244	2.4	1,039	23	2.2	295	10	3.4	117	-	0	206
Over 64 years	2,655	123	4.6	74	-	0	-	-	-	-	-	-	49
Age not stated	1,037	65	6.3	437	5	1.1*	200	-	0	124	6	4.8*	35
All Ages	30,139	999	3.3	17,422	675	3.9	9,982	514	5.1	3,852	137	3.6	1,126

* Rate based on less than 10 days of illness.

TABLE 3 - NUMBER OF RECORDED ILLNESSES BY TYPE, AREA AND AGE GROUP

Age Group	Person Days of Record	Type of Illness: All Types	Nose	Throat	Gastro-intestinal	Skin	Eye	Ear	Nose and Throat	Ear and Nose	Eye and Nose	Other Combinations and Types
NORTH BEACH												
Under 5 years	17,234	219	51	51	39	29	16	2	4	1	1	25
5 - 9 years	9,751	134	49	31	23	10	6	1	2	-	2	10
10 - 19 years	14,938	176	68	18	25	16	10	13	6	-	2	18
20 - 44 years	69,219	446	169	51	111	42	27	12	19	1	2	12
45 - 64 years	33,587	106	47	18	14	4	6	5	4	1	1	6
Over 64 years	5,910	12	3	3	2	2	-	-	-	-	-	2
Not Stated	3,814	10	3	4	-	1	2	-	-	-	-	-
All Ages	154,453	1,103	390	176	214	104	67	33	35	3	8	73
SOUTH BEACH												
Under 5 years	15,371	196	49	35	34	25	7	7	8	1	1	29
5 - 9 years	11,090	141	40	30	18	12	12	5	8	2	2	12
10 - 19 years	13,393	201	52	21	30	18	25	24	3	2	4	22
20 - 44 years	60,335	403	144	77	74	33	24	7	17	1	3	23
45 - 64 years	27,320	144	53	24	38	5	4	1	7	-	-	12
Over 64 years	6,867	27	6	5	5	1	1	-	-	1	2	6
Not Stated	3,782	22	5	3	6	1	-	-	4	-	-	3
All Ages	138,158	1,134	349	195	205	95	73	44	47	7	12	107

TABLE 4 - RECORDED ILLNESSES PER 1,000 PERSON-DAYS BY TYPE, AREA AND AGE GROUP

Age Group	Type of Illness: All Types	Nose and Throat	Gastro-intestinal	Skin	Eye, Ear and Other
			NORTH BEACH		
Under 5 years	12.8	6.2	2.3	1.7	2.6
5 - 9 years	13.8	8.4	2.4	1.0	2.0
10 - 19 years	11.9	6.2	1.7	1.1	2.9
20 - 44 years	6.4	3.4	1.6	0.6	0.8
45 - 64 years	3.2	2.1	0.4	0.1	0.6
Over 64 years	1.9	1.0	0.3	0.3	0.3
Not Stated	2.6	1.8	0	0.3	0.5
All Ages	7.0	3.7	1.4	0.7	1.2
			SOUTH BEACH		
Under 5 years	12.7	6.0	2.2	1.6	2.9
5 - 9 years	12.7	7.0	1.6	1.1	3.0
10 - 19 years	15.0	5.7	2.2	1.3	5.8
20 - 44 years	6.8	4.0	1.2	0.6	1.0
45 - 64 years	5.3	3.1	1.4	0.2	0.6
Over 64 years	4.0	1.6	0.7	0.2	1.5
Not Stated	5.9	3.2	1.6	0.3	0.8
All Ages	8.3	4.3	1.5	0.7	1.8

TABLE 5 - RECORDED ILLNESSES PER 1,000 PERSON-DAYS BY AREA, AGE GROUP AND SWIMMING FREQUENCY

Age Group	No Swimming			1-9 Days of Swimming			10-24 Days of Swimming			24+ Days of Swimming		
	Person Days	No.of Ill-nesses	Rate per 1,000	Person Days	No.of Ill-nesses	Rate per 1,000	Person Days	No.of Ill-nesses	Rate per 1,000	Person Days	No.of Ill-nesses	Rate per 1,000
NORTH BEACH - BOTH SEXES												
Under 5 years	4,839	37	7.6	5,680	81	14.3	4,139	61	14.7	2,576	40	15.5
5 - 9 years	346	-	0	3,580	52	14.5	4,170	62	14.9	1,655	20	12.1
10 - 19 years	1,992	12	6.0	4,296	47	10.9	5,023	73	14.5	3,627	44	12.1
20 - 44 years	32,156	127	3.9	25,523	201	7.9	9,014	86	9.5	2,526	32	12.7
45 - 64 years	25,496	74	2.9	5,894	27	4.6	1,338	3	* 2.2	859	2	* 2.3
Over 64 years	5,680	12	2.1	230	-	0	-	-	-	-	-	-
Not Stated	2,645	7	* 2.6	968	-	0	65	-	0	136	3	* 22.1
All Ages	73,154	269	3.7	46,171	408	8.8	23,749	285	12.0	11,379	141	12.4
SOUTH BEACH - BOTH SEXES												
Under 5 years	5,414	43	7.9	5,858	81	13.8	2,594	51	19.7	1,505	21	14.0
5 - 9 years	1,204	15	12.5	3,724	49	13.2	4,351	57	13.1	1,811	20	11.0
10 - 19 years	1,251	11	8.8	4,586	66	14.4	3,765	51	13.5	3,791	73	19.3
20 - 44 years	27,181	152	5.6	23,377	169	7.2	7,581	65	8.6	2,196	17	7.7
45 - 64 years	22,492	115	5.1	3,410	25	7.3	991	4	* 4.0	427	-	0
Over 64 years	6,402	25	3.9	404	2	* 5.0	61	1	* 16.4	-	-	-
Not Stated	2,098	9	* 4.3	1,114	11	9.9	446	-	0	124	1	* 8.1
All Ages	66,042	370	5.6	42,473	403	9.5	19,789	229	11.6	9,854	132	13.4

* Rates based on less than 10 illnesses.